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LEXICAL ENCODING AND PERCEPTION OF PALATALIZED CONSONANTS IN L2 RUSSIAN

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Previous studies have investigated the link between lexical encoding and perception by analyzing contrasts that differ in primary features of articulation, e.g., /l/ vs. /ɹ/. The goal of this study was to explore how the lexical encoding of contrasts that differ in the secondary feature of palatalization, e.g., /l/ vs. /lʲ/, was affected by learners' perceptual abilities. The participants in the study were 40 American English learners of Russian and 10 Russian native speakers. Error rates on an auditory word-picture matching task measured learners' ability to encode and retrieve words with the plain/palatalized contrast. Learners' scores on an ABX task assessed their perceptual abilities. Results suggest that learners did not have clearly separated lexical representations for words with palatalized and plain consonants. They accepted most nonwords as possible productions of the target words, especially in the word-final position, whereas Russian native speakers did not. The ability to perceive the contrast between plain and palatalized consonants was found to be helpful in establishing separate lexical representations for words with this contrast among advanced learners, even though it did not guarantee that words with palatalized consonants would be encoded and retrieved as such.

INTRODUCTION

The secondary feature of palatalization, which is phonemic in Russian, is "the superimposition of a raising of the front of the tongue toward a position similar to that for /i/ on a primary gesture" (Ladefoged & Maddieson, 1996, p. 363). There are 15 palatalized consonants in Russian that are paired with plain counterparts. They occur in word-initial, word-medial, and word-final positions, both before vowels and consonants. The most important acoustic cues for palatalization are the first (F1) and second formant (F2) transitions from consonants into subsequent vowels (Halle & Jones, 1959). The F1 of a vowel following a palatalized consonant increases, whereas F2 is high at the beginning of the vowel and then decreases throughout the vowel. The F2 onset of a vowel following a plain consonant is much lower. A vowel that precedes a palatalized consonant has a decreasing F1 and an increasing F2 throughout, but these differences are less salient. The release in palatalized consonants is louder and longer than in plain counterparts (Kochetov, 2002). Depending on the characteristics of a vowel and palatalization status of surrounding consonants, vowel durations can also either increase or decrease (Ordin, 2011).

In perception, learners tend to map plain and palatalized consonants to a single category with different levels of goodness of fit. Plain consonants represent a good fit, whereas palatalized consonants are categorized as a poorer fit to the native category (Rice, 2015). Palatalized consonants are differentiated more easily from plain ones in prevocalic position than in word-final position due to the i-transition or a glide that accompanies palatalization as a cue during the following vowel (e.g., Kochetov, 2002). Under certain conditions, for instance, the perception of palatalized obstruents word-finally, L2 learners do not differ significantly from listeners with no knowledge of Russian. In a study by Lukyanchenko and Gor (2011), L2 learners of Russian with an average of three years of formal instruction in Russian performed similarly to naïve English native speakers on a high-variability AX task that tested the perception of palatalized and plain labials /p – p^j/ and coronals /t – t^j/.

The goal of the current study is to investigate how L2 Russian learners' ability to perceive the contrast between plain and palatalized consonants affects their ability to lexically encode and retrieve words with this contrast and to examine how this relationship unfolds for contrasts that differ in secondary rather than primary features of articulation.

LITERATURE REVIEW

In the first language, the link between lexical encoding and perception is transparent because both domains are reasonably presumed to employ the same phonological categories. In a second language, the interaction between perception and lexical encoding is not as straightforward due to interference of the native categories during processing.

Proponents of the "categories first" approach maintain that the accurate perception of a contrast is necessary for the acquisition of targetlike lexical representations. Inaccurate perception results in single-category assimilation, when two nonnative phonemes are assimilated to the same native category. Consequently, minimal pairs containing that contrast are possibly stored as homophones in the lexicon. Pallier, Colomé, and Sebastian-Gallés (2001) used a repetition-priming paradigm to test fluent Spanish-dominant and Catalan-dominant bilingual speakers of Spanish and Catalan. The participants performed lexical decisions on a list of words containing Catalan-specific phonemic contrasts /e-ɛ/, /o-ɔ/, /s-z/, which do not exist in Spanish. Unlike the Catalan-dominant participants, the Spanish-dominant bilinguals exhibited a repetition effect in the minimal pair condition, whereas their overall performance was similar to that of the Catalan bilinguals. These results indicate that although the Spanish bilinguals mastered the Catalan lexicon, they processed Catalan words with these contrasts as though they were homophones. In a previous study, Pallier, Bosch, and Sebastian-Gallés (1997) found that many early Spanish-dominant bilinguals exhibit a much flatter discrimination function for a continuum between /e-ɛ/ as compared to Catalan-dominant bilinguals, suggesting that they have not established two separate categories despite early and sustained exposure to the contrasts.

The other approach, called "lexicon first," supported by the Direct Mapping from Acoustics to Phonology model (Darcy, Dekydtspotter, Sprouse, Glover, Kaden, McGuire, & Scott, 2012), proposes that the lexical encoding of contrasts is independent of phonetic category formation and can precede it. Learners can use other resources, such as orthography or metalinguistic representations, to establish a lexical contrast. Darcy et al. (2012) examined the acquisition of French vowels /u-y/ and /œ-ɔ/ by American English learners through an ABX and a lexical decision task with repetition priming. Learners' performance on the ABX with /u-y/ was significantly different from that of French native speakers, regardless of their level of proficiency, which means that learners did not yet establish fully robust phonetic categories for the vowel contrasts. On the lexical decision task, intermediate learners exhibited priming effects on the /u-y/ contrast, whereas advanced learners behaved similarly to the French native speakers. These findings suggest that in a lexical task, learners (here, the advanced group) can detect and use more acoustic cues than what they need or use for a nonlexical segmental categorization task. It is possible that at the lexical level a distinction can be made, which may not be implemented in a nonlexical categorization task like ABX. Language experience can help learners overcome spurious homophony and establish separate representations of word forms.

Gor (2014) is the only study to our knowledge that has investigated the perception and lexical encoding of palatalized consonants by heritage learners of Russian and L2 learners of Russian. The participants performed an AXB and a picture-word discrimination task on minimal pairs with /t-t^j/ and /p-p^j/ word-finally, as well as other pairs of consonants in a prevocalic condition /C^{j}V-CjV/. The results of the study showed that L2 learners had accuracy rates of around 70-80% in all three conditions on the ABX task and accuracy rates of 60-76% on the picture-word discrimination task. However, Gor (2014) did not provide a list of minimal pairs that were used in the study, nor was there any mention of whether the words were familiar to learners. The words that form minimal pairs with plain and palatalized consonants in Russian rarely constitute the active vocabulary of Russian learners, especially at lower levels of proficiency. If learners were not familiar with the words in the picture-word discrimination task, then they relied on their phonetic rather than phonolexical knowledge to perform the task. Moreover, the prevocalic condition tested in the study did not represent a clear opposition between plain and palatalized consonants, since prevocalic consonants followed by a palatal /j/ and a vowel tend to be palatalized in Russian, viz. C^{j}jV rather than CjV (Avanesov, 1972).

The current study only used words that were familiar to learners to ensure that participants had already encountered them in spoken and/or written input and established lexical representations for them. Two syllable positions, word-final and intervocalic, were examined because syllable position is expected to have an effect on the lexical encoding of the contrast. The perceptual difference between plain and palatalized consonants in the prevocalic position might be more salient for learners and help them accurately represent words using the palatalization contrast. We used correlational analysis to uncover the relationship between perception and lexical encoding and, consequently, to add to the existing knowledge of the acquisition of contrasts that differ in secondary features of articulation.

RESEARCH QUESTIONS AND HYPOTHESES

The following questions guided the current investigation:

1. Do American English learners of Russian lexically encode words with plain and palatalized consonants separately in L2 Russian?
2. What is the relationship between perception and lexical encoding/retrieval for these learners?

We hypothesize that American learners of Russian should encode plain and palatalized consonants separately, especially at higher levels of proficiency. The perceptual difference between plain and palatalized consonants can alert learners to the existing contrast, especially in intervocalic position. Also, orthographic and metalinguistic knowledge might explicitly direct learners to the differences between plain and palatalized consonants. Palatalized and plain consonants share the same graphemes in Russian, but palatalization is not opaque in spelling. Palatalized consonants are either followed by a letter called the “soft sign” <ь> or a special set of palatalized series vowel letters <и, е, я, ё, ю>.

Regarding the second research question, it is hypothesized that learners' ability to encode palatalized consonants is related to their ability to perceive the distinction. If learners are able to differentiate between plain and palatalized consonants in perception, this reinforces the need to encode the difference. If learners cannot perceive the difference, accurate encoding is still possible if by accurate encoding we mean separate representations for a lexical contrast.

METHOD

Participants

The participants were 40 learners of Russian, all native speakers of American English, from intact classes enrolled in an intensive Russian summer program that offered instruction at nine levels. Enrollment in levels was based on the results of an in-house placement test and previous experience with the language. Participants in each level were tested during their regular Russian Phonetics class. Intermediate participants (9 males, 11 females) aged 19-40 (M = 25.1) included learners enrolled in levels 3-5. Their length of Russian instruction did not exceed 3 years. The advanced group (8 females, 12 males) aged 22-41 (M = 25.9) included learners enrolled in levels 7-9. Their length of Russian instruction was more than 4 years. Ten Russian native speakers (2 males, 8 females) aged 26-42 years (M = 33.3.) served as a control group.

Materials and procedure

Auditory word-picture matching task

An adapted version of the auditory word-picture matching task (AWPM) (Hayes-Harb & Masuda, 2008) was used to examine learners' lexical encoding of words containing plain and palatalized consonants. Stimuli comprised 20 real words contrasting five pairs of coronal consonants, /t-tʲ/, /s-sʲ/, /n-nʲ/, /l-lʲ/, /r-rʲ/, appearing in word-final or intervocalic position (e.g., [solʲ] 'salt'). No minimal pairs were used. All words were selected from the textbook *Live from Russia. Volume 2* (Lekic, Davidson & Gor, 1997), which is widely used in first-year Russian courses. In order to ensure that all intermediate and advanced learners would know the words, the materials were piloted with high-beginners who had less than a year of instruction. In addition, participants' familiarity with the target words was evaluated at the end of the testing session. Learners received a list of the target words and fillers in Russian. They were asked to translate the words into English and choose a category that best described their knowledge of each word:

1) I have seen it, I know it, I can use it

2) I saw it, I don't know it

3) I never saw it, I don't know it.

Nine target words (0.9 %) out of 1000 responses were marked as unfamiliar or translated inaccurately. All filler items were familiar to all the participants. The number of syllables, stress and part of speech could not be controlled due to the limits imposed by the vocabulary size of intermediate participants. In word-final position, all target consonants were preceded by the same vowel. In intervocalic position, the vowels that followed the target consonants were the same in words that formed pairs. Twenty test nonwords were created from these real words by replacing the plain or palatalized consonant by its counterpart (e.g., *[sol]). Another 20 control nonwords were created by replacing the target consonant by another consonant differing in primary articulation (e.g., *[som^j]). Twenty additional filler words were selected (e.g., [sumka] 'purse'), resulting in a total of 80 trials.

During the task, participants saw a picture and were asked to indicate whether the pronunciation of the word they heard was correct and matched the picture by pressing a "Yes" or "No" button as quickly as possible. No written forms were presented. The response timeout was 2000 ms.

ABX categorization task

This task evaluated learners' abilities to perceptually distinguish the plain vs. palatalized contrast. Ten pairs of CVCVC nonwords were created, in which palatalized consonants alternated with plain counterparts in word-final and intervocalic positions. The vowel /a/ preceded and/or followed the target consonants (e.g., [vatak] – [vat^{j}ak]). Syllables with target consonants were always stressed. Ten pairs of control nonwords with a similar structure contained common contrasts. Each pair was arranged into a triplet (A-B-X) where X was similar to either A or B (e.g., A-[vatak] B-[vat^{j}ak] X-[vat^{j}ak] (X = B). Four counterbalanced orderings were used (ABA, ABB, BAA, BAB), resulting in 40 test triplets. For the control triplets, only two orderings were used, and were counterbalanced for different nonwords; test and control triplets amounted to 60 total trials. Two female Russian native speakers produced the A and B tokens, whereas the X tokens were produced by a male speaker. The interstimulus interval was 500 ms and the response timeout was 2000 ms. Both tasks were administered with DMDX (Forster & Forster, 2003).

RESULTS

Auditory word-picture matching task

Overall, the error rates in all conditions were low for all groups, except in the test nonword condition, where the two learner groups displayed a high error rate (Figure 1). A generalized linear mixed model was run in SPSS 24 on the error rates. The factors group (Russian native speakers, advanced learners, intermediate learners) and condition (target word, test nonword, control nonword, filler) were declared as fixed effects. The factor participant and item were chosen as random effects. Type III tests of fixed effects for error rates revealed that there was a main effect of group, $F(2, 3988) = 30.53$, $p < .001$, condition, $F(3, 3988) = 93.6$, $p < .001$, and an interaction between the two factors, $F(6, 3988) = 14.25$, $p < .001$. Bonferroni post hoc tests showed that intermediate learners with a mean error rate of 82% (95% confidence interval [CI] = 77–85) made significantly ($p = .008$) more errors than advanced learners with a mean error rate of 74% (CI = 69–78) in the nonword condition, when presented with test nonwords */sol/ or */stol^j/ instead of the real words /sol^j/ 'salt' or /stol/ 'table'. The confidence intervals for the two groups' means on this condition are not overlapping but close, and the mean difference between the two average error rates was 8, (CI = 2–14). Both groups of learners were significantly less accurate than Russian native speakers (M = 4%, CI = 2–8) ($p < .001$ for both groups of learners) on this condition. The mean difference between advanced learners' and Russian native speakers' average error rates was 69 (CI = 63–76) and the mean difference between intermediate learners' and Russian native speakers' error rates was 77 (CI = 72–83), indicating a robust effect.

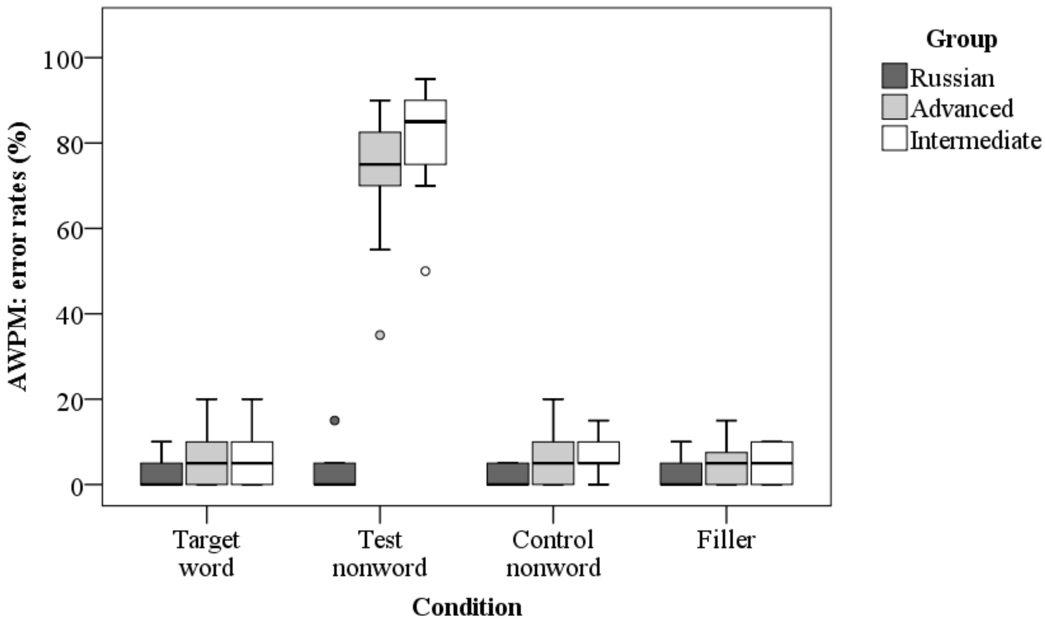


Figure 1. Box plots of error rates for each group and condition. Horizontal lines are medians, boxes show the interquartile range (IQR) representing 50% of the cases, whisker bars extend to 1.5 times the IQR. Outliers (circles) are cases with values between 1.5 and 3 times the IQ range, i.e., beyond the whiskers.

An additional generalized linear mixed model was run on the error rates to examine the effects of syllable position and the palatalization status of the target consonant in the test nonword condition only. The factors group (Russian native speakers, advanced learners, intermediate learners), position (final, intervocalic), and palatalization status (plain, palatalized) were declared as fixed effects. The factor participant was chosen as a random effect. Type III tests of fixed effects for error rates revealed that there was a main effect of group, $F(2, 995) = 56.59$, $p < .001$, palatalization, $F(1, 995) = 4.4$, $p = .036$, and position, $F(1, 995) = 53.68$, $p < .001$, but there were no significant interactions. Additional generalized linear mixed models were run on the error rates to examine the effects of syllable position and palatalization for each group separately. No main effects of syllable position or palatalization were found in the data of Russian native speakers. There was a main effect of position, $F(1, 396) = 20.05$, $p < .001$, in the data of intermediate learners, who made significantly ($p < .001$) more errors in the word-final position (M = 91%, CI = 84–96) than in intervocalic position (M = 73%, CI = 62–82). Confidence intervals do not overlap, and the mean difference was 18, CI = 7–29. There was also a main effect of position, $F(1, 396) = 32.12$, $p < .001$, as well as a marginally significant effect of palatalization, $F(1, 396) = 3.77$, $p = .053$, and a marginally significant interaction between position and palatalization, $F(1, 396) = 3.77$, $p = .053$, in the data of advanced learners. Overall, advanced learners made fewer errors in intervocalic (M = 61%, CI = 52–69) than in word-final position (M = 87%, CI = 81–92). In intervocalic position, the error pattern was modulated by palatalization. Advanced learners made significantly ($p < .001$) more errors by accepting test nonwords with a plain consonant (M = 72%, CI = 61–81), e.g., */z^{j}elonij/ instead of /z^{j}el^{j}onij/ ‘green’, than test nonwords with a palatalized consonant (M = 49%, CI = 38–60), e.g., */xol^{j}odnij/ instead of /xolodnij/ ‘cold’ (see Figure 2). Again, the CIs of the two distributions are not overlapping, and their mean difference was 24, CI = 10–37.

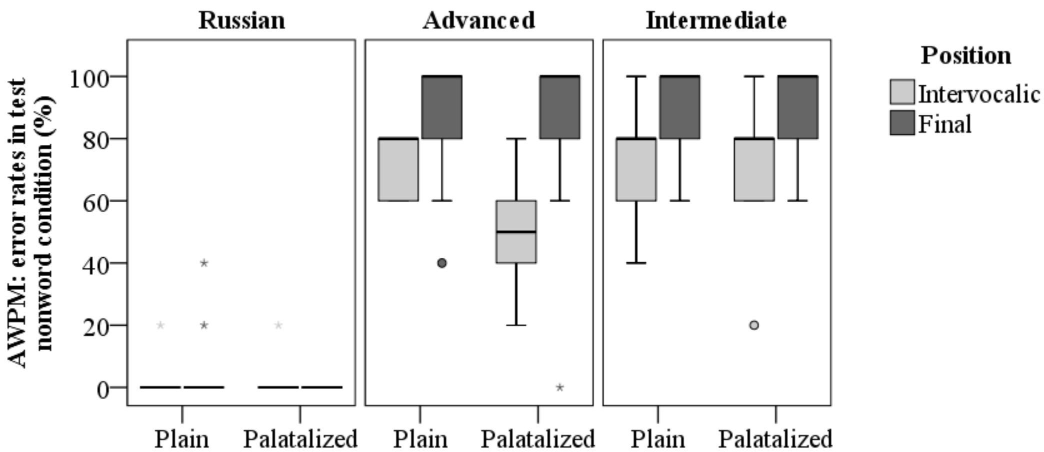


Figure 2. Box plots of error rates on nonwords with plain and palatalized consonants in both positions for each group. See Fig. 1 caption for an explanation of the box plot.

ABX task

As shown in Figure 3, error rates were low in all groups in the control condition, but in the test condition, the learner groups made on average 29% errors. A generalized linear mixed model was run in SPSS 24 on the error rates. The factors group (Russian native speakers, advanced learners, intermediate learners), condition (test, control), and position (intervocalic, final) were declared as fixed effects. The factor participant and item were chosen as random effects. Type III tests of fixed effects for error rates revealed a main effect of condition, $F(1, 2988) = 31.15$, $p < .001$, group, $F(2, 2988) = 8.81$, $p < .001$, and a significant interaction between group, condition and position, $F(7, 2988) = 7.28$ $p < .001$. Bonferroni post hoc tests indicated that learners made significantly ($p < .01$) more errors in the test condition (intermediate: M = 27%, CI = 22–35; advanced: M = 30%, CI = 25–38) than in the control condition (intermediate: M = 4%, CI = 2–7; advanced: M = 7%, CI = 4–13) while Russian native speakers' performance in the test condition (M = 2%, CI = 1–5) was not significantly different from that in the control condition (M = 2%, CI = 1–6). The mean difference between average error rates in the test and control condition for intermediate learners was 23, CI = 19–29, and for advanced learners it was also 23, CI = 19–29. There were no significant differences between the three groups of participants in the control condition. Syllable position had a significant effect ($p < .001$) on learners' performance in the test condition. Both intermediate and advanced learners made significantly more errors in word-final position (intermediate: M = 37%, CI = 29–45; advanced: M = 43%, CI = 35–51) than in intervocalic position (intermediate: M = 18%, CI = 12–23; advanced: M = 17%, CI = 12–22). The confidence intervals between the two positions are not overlapping for either group, indicating a consistent effect. The mean difference between the intervocalic and final position for intermediate learners was 19 (CI = 13–26), and for advanced learners it was 27 (CI = 21–33). There was no statistically significant difference between the two groups of learners.

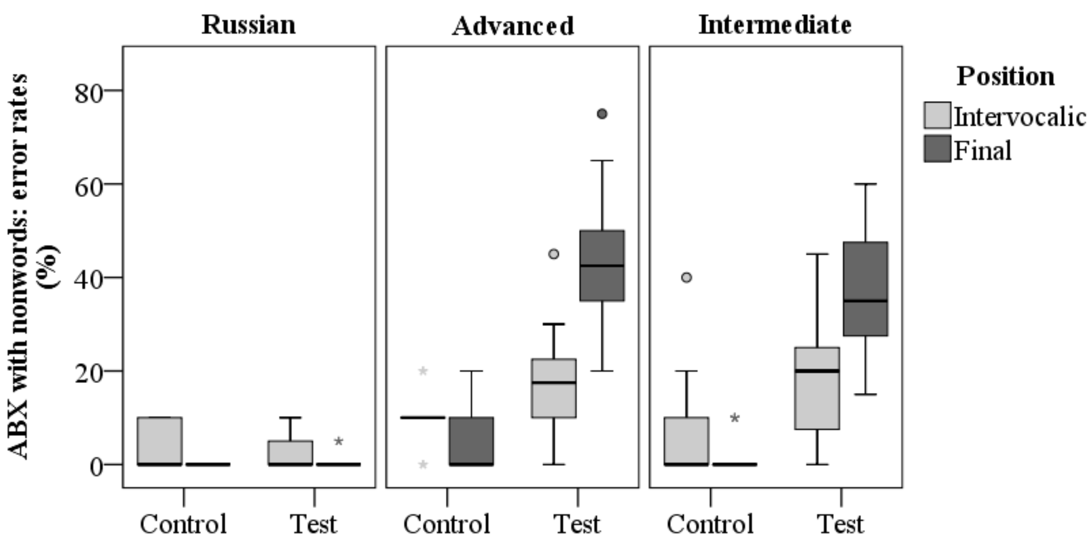
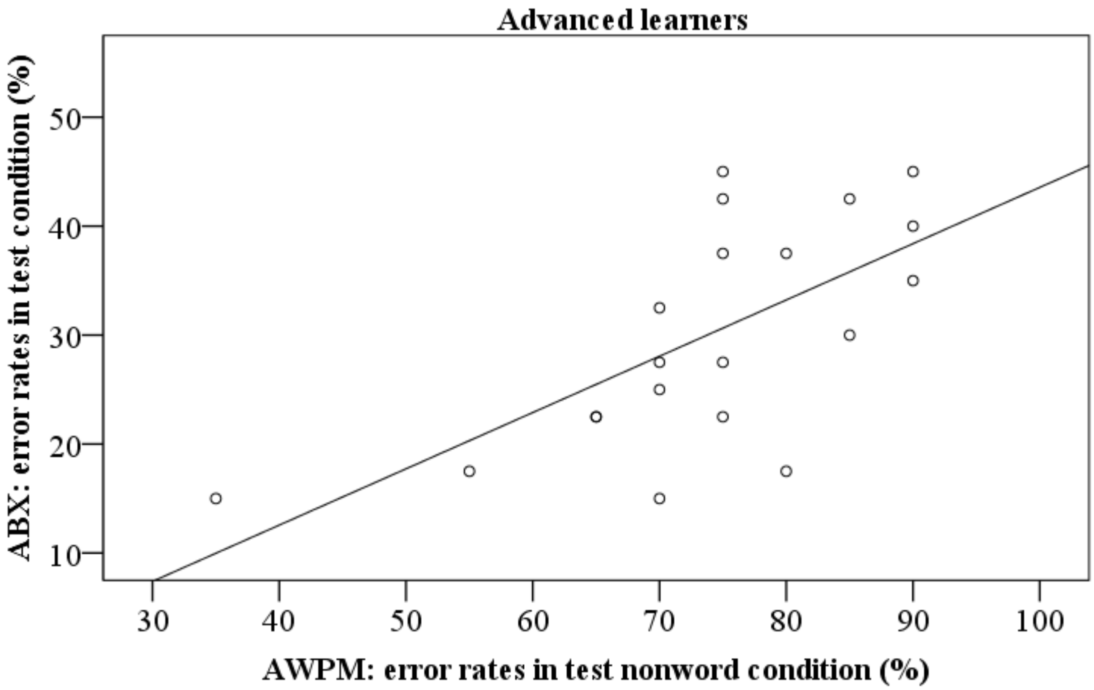


Figure 3. Box plots of error rates for each group, condition, and position. See Fig. 1 caption for an explanation of the box plot.

Correlation

Learners' performance on both tasks was correlated to examine the relationship between perception and lexical encoding. The correlational analysis was performed on the error rates in the ABX task and the error rates in the test nonword condition of the AWPM task for each group separately. For intermediate learners, no relationship was found between their scores on each task, $r(18) = .267$, $p = .256$. However, there was a strong, positive, statistically significant relationship between error rates in both tasks for the advanced group, $r(18) = .657$, $p = .002$. Higher error rates in the ABX were related to higher error rates in the AWPM (Figure 4).



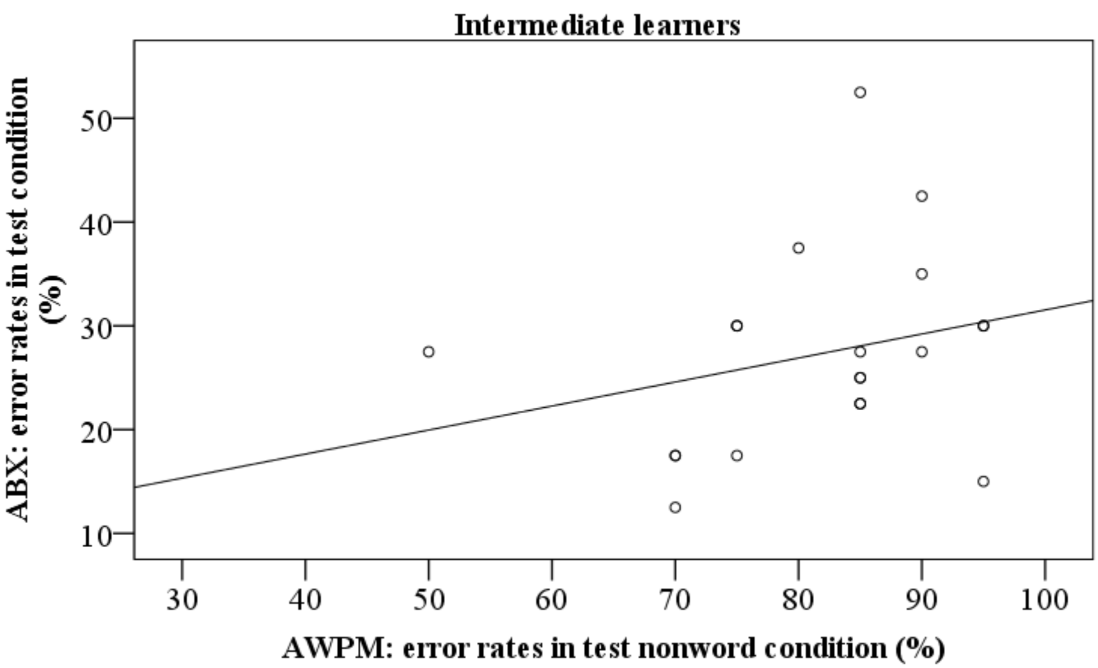


Figure 4. Scatterplots of error rates in both tasks. Upper panel: advanced learners; lower panel: intermediate learners.

DISCUSSION

The goal of the study was to examine the relationship between learners' perceptual abilities and their lexical encoding of words containing plain and palatalized consonants. The first research question asked whether American English learners encoded a clear difference between plain and palatalized consonants in L2 Russian words. The results showed that learners, overall, were not able to encode and retrieve this contrast clearly even in familiar words. All learners mistakenly accepted most test nonwords as correct productions of highly familiar Russian words. Intermediate learners accepted nonwords with either plain or palatalized consonants regardless of syllable position, whereas advanced learners showed an asymmetry in intervocalic position, rejecting test nonwords with a palatalized consonant much more often than nonwords with a plain consonant. Such asymmetry in error rates is reminiscent of findings that rejecting a nondominant (palatalized) category as incorrect in test nonwords is somewhat "easier" than rejecting a dominant (plain) category (Darcy, Daidone & Kojima, 2013). Furthermore, additional acoustic cues to the contrast carried by vowels in intervocalic position, as well as orthographic differences in vocalic graphemes, might have made the difference between target words and test nonwords more salient to learners. Such a strategy, however, might indicate that advanced learners have erroneously encoded the difference in terms of vowels, rather than consonants. In word-final position, since both extra cues are not available, we observed extremely high error rates of 87% for both palatalized and plain test nonwords.

The second research question probed the relationship between perception and lexical encoding. The ABX results showed that learners' perception of the plain/palatalized contrast was not very stable. The two groups showed the same pattern, and they made errors in almost one-third of all trials. The word-final position was more perceptually challenging than the intervocalic position.

The correlational analysis revealed a strong relationship between the perception and lexical encoding of the contrast in the performance of advanced, but not intermediate learners. The learners with the highest error rates in the ABX also had the highest error rates in the AWPM. There was not a single advanced learner with a high error rate in the ABX and a low error rate in the AWPM, which supports the claim that lexical encoding is dependent on learners' perceptual abilities. However, two learners with comparatively low error rates of 15% and 18% in the ABX obtained high error rates (70% and 80%) in the AWPM task. Thus, good perceptual discrimination of the plain/palatalized contrast does not guarantee that words with this contrast are encoded accurately in the mental lexicon. Possibly, despite being able to perceive the difference between plain and palatalized consonants, advanced learners treated Russian palatalized consonants as free variants, and failed to reject most test nonwords in the AWPM task.

In conclusion, our findings suggest a close link between the perception and lexical encoding of contrasts based on the secondary feature of palatalization. The ability to perceive the contrast between plain and palatalized consonants provides a foundation for learners to encode this difference in the mental lexicon. However, perception alone is not enough to guarantee accurate lexical representations of words with a palatalization contrast. The exact reasons for this difficulty are unclear. Future research is needed to uncover the possible influence of orthography and metalinguistic knowledge on the lexical encoding of palatalized consonants in L2 Russian.

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